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25 YEAR RE-REVIEW

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Evacuation Equipment

1. At the Vrsovice Plant, the equipment for evacuating tubes consisted of:

   a. Oil rotary pump, electrically driven.

   b. Mercury diffusion pump with resistance spiral, electrically heated.

   c. Mercury monometer.

   d. Glass cooler to precipitate the steam and to absorb the impurities; it had a glass vacuum container holding cooling ingredients (usually dry ice or liquid air; the liquid air was produced in the plant in a Linde machine located in the Social Building and Warehouse 1.).

   e. Glass evacuating tubing, sealed to a bronze tube which was accordion-pleated to counterbalance the expansion of the glass tubing. This evacuating tubing was used for high and medium-power tubes; a glass evacuation fork with several evacuating outlets was used for medium-power tubes and low-power special tubes.

   f. A rubber hose which connected the oil rotary pump with the diffusion pump.

   g. Tempering furnace, bell-shaped, gas-heated or electrically heated by a resistance spiral.

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h. Small control triode sealed to the glass tubing between the cooler (d above) and the evacuation tubing (e above).

i. Current and voltage source (the heater transformer, anode rectifier, and grid rectifier) for the control triode (h, above).

j. Inductor to control rough vacuum.

2. All this evacuation equipment was assembled in the plant. Most of the parts were produced there except some of the oil pumps and some of the mercury diffusion pumps which were of foreign origin, and vacuum glass containers which were manufactured in another Czechoslovak plant. The evacuating equipment described above formed one unit. There were 13 such units in the plant. They were located in the Main Production Building on the second floor. [2], All of the units were installed during 1946 and 1947, with the exception of the units which were built during 1952. [3].

Degassing Equipment

3. Degassing equipment for high-power transmitter tubes with external anode (excepting ACT 9, ACM 18, ACM 3, ACR 2, ACS 2) consisted of:

a. Iron stand, set on four porcelain insulators, on which the tube was placed.

b. Air cooler for forced air cooling.

c. Water cooler.

d. Water resistors (rectangular shaped) [4]. which were connected to the water cooler with a rubber hose.

e. Two monitors (one for water current, the other for air current) for controlling the circuit electrically. [4].

f. Heater voltage sources for the tubes:

(1) Dynamo with adjustable voltage for direct current. The dynamo was connected by a fixed clutch to a three-phase electric motor, which was controlled by a switch. [5]. The dynamo was used for the equipment (for testing CAT 10, CAT 12A, CAT 20, CAT 201, CAT 14C, CAT 17C) [6]. on the first floor of the Main Production Building [7]. where it was located. The dynamo was rated at 35 v and 1,000 amp.

(2) Heater transformer with an inductance. [8]. These transformers were of 20 KVA, 220/40 v and supplied the equipment on the second floor of the Main Production Building [5]. where they were located.

(3) Heater transformer which had adjustable auto-transformer was connected to the primary winding. This transformer was of 3 KVA, 220/30 v and was located on the second floor of the Main Production Building [9]. and supplied equipment there for use on CAR 6, CAR 4, CAR 2, CAT 9, ACT 16, CAT 6, ACT 14, CAT 6K, CAM 3, and CAT 3.

g. Two anode rectifiers with three GT 15 tubes apiece with a booster for voltage regulation up to 1,500 v and up to 15 amp. (For a very short period during each testing, each of these anode rectifiers delivered up to 20 amp.) Both rectifiers were located in the Main Production Building, second floor. [7., 5].

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c. Generator for high-frequency induction heating. Oscillator with a transmitter triode and several induction coils of various sizes and shapes.

There were five units of this equipment in the plant. Three units were located in the Main Production Building on the second floor. 13. The glass parts of these three units were of molybdenum glass. Each of the units was placed in an iron frame construction, covered by sheet metal or meshed wire. The evacuation equipment was placed in the lower front part of the iron frame. The tube was placed in the upper front part of the framework (above the evacuation equipment) for degassing and evacuating; the degassing equipment filled the rear part of the iron frame. Four or five tubes could be processed in this equipment at the same time, with the exception of the GT 15 tube (only one unit of this type of tube could be processed at one time). The two remaining units of the degassing equipment were portable. 14.

Pre-evacuation of the Tubes

7. The pre-evacuation of the tubes was performed on the evacuation equipment described above. The pre-evacuation process determined whether the tube was vacuum-proof. This process was performed with envelopes sealed to large copper anodes with the exception of ACT 9, ACM 1S, and some others. The pre-evacuation process was applied to the following sealed tubes: CAT 10, CAT 12A, CAT 20, CAT 201, CAT 14C, and CAT 17C, which were high-power transmitter tubes of the largest size. After a so-called "good" vacuum (10^{-5} or 10^{-6} mm. Hg) was achieved, which was controlled by an inductor and control triode with reverse grid current, the tube was set into the tempering equipment, where it was heated until a temperature near the transformation point of the glass was attained. This temperature was maintained for a certain period, then the temperature was gradually lowered to about 60° C. and the tube was removed from the tempering furnace. This tempering process was to remove the internal tension of the glass created during the sealing. The pre-evacuation process was also applied to the other high-power transmitter tubes as well as to medium-power transmitter tubes and to the GT 15 tube, but these tubes were not submitted to the tempering process. Pre-evacuation took place in the Main Production Building, second floor. 15.

Degassing and Evacuating Process

8. The degassing process was performed:

a. By direct-current heating, which meant that some parts of the tube were heated by a connection to direct current, thereby releasing the absorbed gases. The principal parts affected were the cathode and connecting parts.

b. By high-frequency induction heating; a high frequency coil, fed from a generator, was set near the tube, and created an induction field through which the conducting parts inside the tube were heated, releasing the absorbed gases.

c. By heating, created by bombardment with electrons. The electrons, emitted by the cathode, were thrown against a conductive part inside the tube (the anode or grid usually being affected) which was connected to the positive pole of a rectifier. The part bombarded with electrons was heated and released the absorbed gases.

These three procedures were interchangeable during the degassing process.

9. Degassing and evacuating of high-power transmitter tubes with external anode, except ACT 9, ACM 1S, ACM 3, ACR 2, ACS 2, and of the CAR 6, CAR 4, and CAR 2 tubes was done as follows. The tube was placed on the stand and the evacuating tubing was sealed to the pumping equipment which was put in operation. The pumping operation was controlled by an inductor. When the so-called "good" vacuum (10^{-5} mm. Hg.) was reached, the tube was covered by a tempering furnace which was heated close to the transformation point of the glass. According to the size of the tube, it remained under this temperature from one half to one hour. The temperature was gradually lowered to about 60° C., at which point the tempering furnace was removed. A control triode (ion triode) was connected to the current supply and to the measuring instruments which controlled the vacuum. Then an air cooler was set near the anode. For the largest tubes in this category, cooling air was forced into the tube heater terminals. The heater voltage was gradually raised by stages from zero up to the maximum (usually 10% higher than the standard heater voltage in operation). In this way the temperature of the cathode was gradually raised and the absorbed gases released and steadily evacuated. After the cathode was degassed, the cathode voltage was turned down and the anode was connected to an anode rectifier. Then, the bombardment of the anode was performed so that both the cathode heater and anode voltage were gradually increased by stages up to that temperature which made the copper anode turn dark red. After the anode was degassed, it was disconnected from the rectifier, the heating was turned down, and the grid was connected to the anode rectifier. Then, the bombardment of the grid was performed by a procedure similar to that with the anode but with a lower rectifier voltage. These three operations -- cathode heating, bombardment of the anode, and bombardment of the grid -- were repeated. Then came the so-called cold bombardment of the anode and the grid. (The term, cold bombardment, was used for the operation in which the rough impurities adhering to the internal parts of the tube were shot off by high voltage.) The cathode and the anode were connected to a high-voltage transformer for cold bombardment of the anode and then the cathode and the grid were connected to a high-voltage transformer for cold bombardment of the grid. In testing the largest high-power transmitter tubes a voltage from 50 - 80 KV was used for the cold bombardment of the anode and a voltage of 30 - 50 KV was used for the cold bombardment of the grid. The voltage was lower with the small types of tubes in this category. Then a water cooler was placed around the anode and either the bombardment of the anode was performed or the tube was subjected to anode dissipation. Sometimes the reverse (ionization) grid current was observed, which indicated the vacuum in the tube . (The greater the reverse current, the poorer the vacuum.) The degassing and evacuating tubing was closed by sealing off the evacuating tube.

10. The evacuating and degassing of the medium-power transmitter tubes, of the MT and MR tubes, and of the ACT 9, ACM 1S, ACM 3, ACR 2, ACS 2 tubes differed from the process as described above in the following respects:

a. Two AC tubes were always processed at the same time so that the individual operations, except heating, were performed alternately.

b. The molybdenum anode of the MT and MR tubes, during the degassing process, was heated until it turned light yellow.

c. After the DEM 2, DET 2, DET 3 tubes were subjected to anode dissipation, the tungsten thoride cathode was carbonized (by means of napthalene vapors).

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d. All the tubes were subjected to the anode dissipation, but the bombardment of the anode was not alternately used.

e. There was no bombardment of the grid with the MR type tubes (which had no grid).

f. There was no water cooling of the tubes during processing.

11. First in the evacuating and degassing processing of special electronic tubes, tubes were sealed to the evacuating equipment (usually six at the same time; only the GT 15 tubes were handled individually). Then the evacuating equipment was set into operation. The vacuum was controlled by an inductor. The tempering furnace covered the tubes. After the tempering process was finished, the furnace was lifted off and the heating of the cathode started. The heating was performed by an induction coil, fed by a high-frequency generator. Then came the bombardment of the anode. After this came the bombardment of the grid. Then the cathode was heated; subsequently the tube was subjected to anode dissipation and the ionization grid current was controlled. If necessary, some of the operations were repeated. Finally, the evacuating tubing was sealed off.

12. The exceptions to the processes described above /paragraph 11/ were as follows:

a. Prior to the mercury rectifiers (GU 14, GU 11, GT 14, and GT 15) being sealed to the evacuating equipment, mercury was put into the lower part of the stem of the tube.

b. Prior to sealing the RD 200/3.5 tube to the evacuating equipment, the internal system of the tube was reduced. The reducing was performed in hydrogen while the internal system of the tube was heated by an induction coil. (The hydrogen passed through the tube, entering through the lower evacuating tube and leaving through the upper evacuating tube, at which time the hydrogen was burned.) After the bombardment of the grid, and after the cathode was heated, the tungsten thoride cathode of the RD 200/3.5 tube was carbonized with napthalene vapors.

c. The bombardment of the grid was omitted with the GU 6 tube (which had no grid).

13. After the evacuating and degassing process was finished, a record was made of the type and the number of the tube, the date of the testing, the individual operations along with the specific characteristics established, and defects of the tube.

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Comment: Units were not independent. They were supplied from the same dynamo for direct current and with the same anode rectifier.

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